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REPORT NO. 7A1425

ASTRONAUTICS

PRESSURE RELIEF

VALVE NO. 7-0334

EVALUATION TEST OF

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ASTRONAUTICS

REPORT 7A1425
DATE 19 June 1958
MODEL Astronautics
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REPORT NO. 7A1425

ASTRONAUTICS

PRESSURE RELIEF

VALVE NO. 7-0334

EVALUATION TEST OF

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REVISIONS

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FORM A116-2

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1.0 OBJECT:

1.1 The purpose of this test was to evaluate the performance of the 7-03340-1 Pressure Relief Valve which is used on Range Safety Command Battery Canisters.

2.0 CONCLUSIONS:

2.1 The dry relief valve and the electrolyte soaked relief valve maintained differential pressures of 3.2 psid and 8.7 psid, respectively, at an altitude equivalent to 1 millimeter of mercury. No evidence of electrolyte or short circuits were found after the altitude tests. During the short circuit test, the battery canister without a pressure relief valve burst at 340 psig. No rise in pressure occurred during the short circuit test of the battery container equipped with a safety relief valve.

3.0 DESCRIPTION OF SPECIMEN:

3.1 The specimens were two 7-03340-1 Pressure Relief Valves. The spring loaded valves were set for approximately 5 psid.

4.0 TEST PROCEDURE:

4.1 The test setup consisted of the following components:

a) Range Safety Command Batteries Serial No. 48311-3 and 9.
b) Statham Pressure Transducers No. 6389; range 0 to 1000 psig, and No. 3974; range 0 to 100 psia.
c) Helicoid Pressure Gages Serial No. 438; range 0 to 600 psi and Serial No. 406; range 0 to 300 psi.
d) Twenty-eight volt battery pack.
e) Continuous Duty Contactor - SPST - Serial No. L68171.
f) Miscellaneous pipe fittings and valves.
g) C.E.C. Recording Oscillographs Serial No. 283DE3 and 29025.
h) Weston D.C. Volt Meter.
i) BEMCO Environmental Chamber Model FA-100-45.

4.2 The pressure transducer and bleed valve arrangement is shown in Figure 4. The altitude test transducer mounted in test position was calibrated from 5.8 psia to 19.7 psia using the altitude chamber for the range below atmospheric pressure and nitrogen gas above atmospheric pressure. The low range calibration was performed with the pressure relief valve held open to allow the transducer to respond to the chamber pressure.

4.0 <u>TEST PROCEDURE:</u> (Continued)

4.3 The pressure relief valve used for the first altitude test was dry. With the relief valve in place and the batteries fully charged, battery canister No. 4831-1-3 was pressurized to 1 millimeter of mercury within 10 minutes. After this condition was attained, the chamber pressure was returned to ambient pressure. The canister pressure was allowed to reach ambient pressure slowly by opening the bleed valve gradually. After ambient pressure was attained, the canister was opened to check for evidence of electrolyte and short circuits.

4.4 The above procedure (Paragraph 4.3) was used for the altitude test of the electrolyte soaked relief valve. The relief valve and battery canister used in this test were the same as those used in the first altitude test.

4.5 The pressure transducer for the short circuit tests was calibrated from 0 to 300 psig. before mounting on the battery canister. The bleed valve and transducer arrangement was then mounted on the battery canister as shown in Figure 4.

4.6 The first short circuit test was performed on battery canister No. 4831-1-3 without a pressure relief valve. After the canister was pressurized to 3 psig, the batteries were shorted at the contactor switch which was remotely operated behind a protection shield. A record of the canister pressure during the test was made on C.E.C. recording equipment.

4.7 The above procedure, Paragraph 4.6, was used for the second short circuit test using the electrolyte soaked relief valve on battery canister No. 9.

5.0 DISCUSSION OF RESULTS:

5.1 The graphic results of the canister pressure variation for the altitude tests are shown in Figure 1.

5.2 The altitude chamber attained 1 millimeter of mercury after seven minutes of operation for the dry relief valve altitude test. During this time, the battery canister pressure dropped at a varying rate directly related to the rate of chamber depressurization. After 1 mm of mercury was reached, the canister continued to lose pressure for nine minutes. The lowest pressure attained within the test specimen, before the altitude chamber was repressurized, was 6.6 inches of mercury or 3.2 psia. This continuous pressure drop after 1 millimeter of mercury was reached was probably caused by leakage at the relief valve seal since the canister pressure remained constant when the chamber pressure was increased. The canister pressure remained at 6.6 inches of mercury during chamber pressurization. The canister was allowed to return to ambient pressure within 40 seconds.

5.3 Inspection of the canister after the altitude test showed no evidence of electrolyte or short circuits.

5.4 The chamber attained 1 millimeter of mercury after seven minutes of operation for the altitude test of the electrolyte soaked relief valve. During this time the canister pressure drop varied according to the rate of chamber depressurization. The canister pressure reached a low of 10.0 millimeters of mercury or 8.7 psia during the depressurization period and remained at this pressure during chamber repressurization. The canister was allowed to return to ambient pressure within 50 seconds.

5.5 Inspection of the canister after the test showed no evidence of electrolyte or short circuits.

5.6 The electrolyte soaked relief valve attained a higher differential pressure than the dry relief valve and remained at this pressure until the canister was repressurized. This variation in differential pressures at 1 millimeter of mercury indicates that the electrolyte caused the relief valve to maintain a tighter seal than the dry relief valve.

5.7 The electrolyte caused the relief valve to corrode to the extent that several days after the test, it was no longer functional.

5.0 DISCUSSION OF RESULTS: (Continued)

5.8 The original internal leads from the batteries to the cannon plug burned out during the first short circuit test. Doubling the number of leads was necessary in order to discharge the battery for the test. Pictures of the battery canisters after the short circuit tests in the sealed and open positions are shown in Figures 4 and 5, respectively.

5.9 The graphic results of the pressure build-up in the battery canister without the relief valve are shown in Figures 2 and 3. The batteries discharged rapidly causing the canister pressure to increase to a bursting point of 340 psig within 59.5 seconds. A small pressure drop occurred at 59.2 seconds which was probably caused by a small leak in the canister seal. The canister lid was forced open at a screw fastener as shown in Figure 4. Electrolyte was sprayed from the canister after the lid opened. The internal damage is shown in Figure 5.

5.10 The addition of the electrolyte soaked relief valve in the second short circuit test relieved the pressure during the discharge period. The relief valve maintained a constant pressure in the battery canister of 3 psig for the entire test. Electrolyte was sprayed through the relief valve during the test. Internal damage to the batteries and canister is shown in Figure 5.

6.0 DATA BOOK REFERENCE:

6.1 The data from which this report was prepared are recorded in Astronautics Engineering Test Laboratory Note Book No. 7193.

ALTITUDE TEST of RANGE SAFETY COMMAND BATTERY RELIEF VALVE

TABLE I

BATTERY CANISTER EQUIPPED WITH DRY RELIEF VALVE

TIME SEC.	PRESS. IN HG.
0	36.1
2	33.8
5	30.9
8	28.3
10	27.0
14	24.8
18	22.9
22	21.3
26	20.0
33	18.0
48	15.0
95	11.1
110	10.6
150	9.6
190	9.0
230	8.6
340	8.0
440	7.6
560	7.1
680	6.9
840	6.6
891	6.6
894	6.8
895	8.8
896	10.6
898	14.0
899	15.4
900	17.9
902	19.5
904	21.7
906	22.5
908	24.9
910	26.0
914	27.4
918	28.2
920	28.5
926	29.9

TABLE II

BATTERY CANISTER EQUIPPED WITH ELECTROLYTE SOAKED RELIEF VALVE

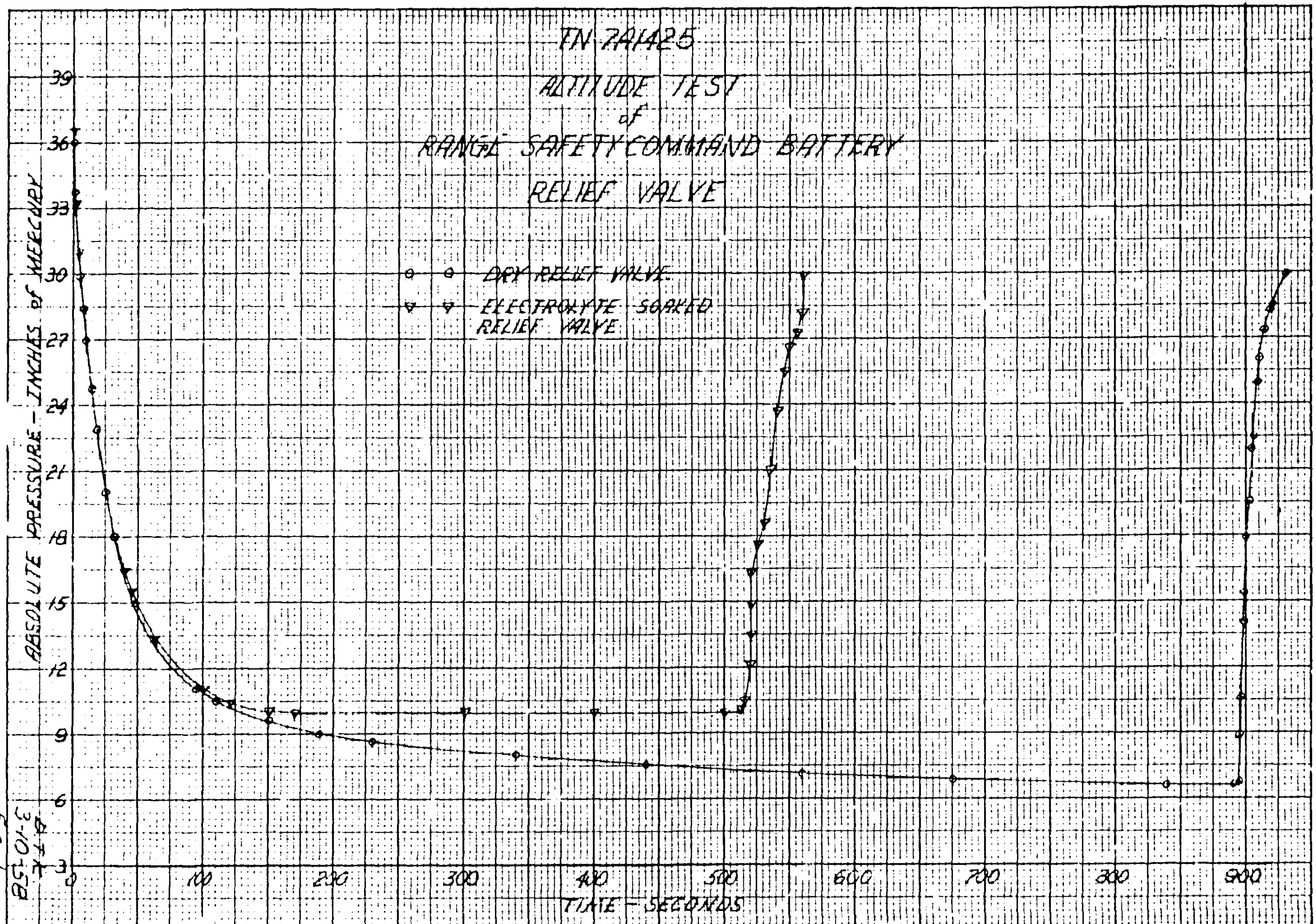
TIME SEC.	PRESS. IN HG.
0.0	36.1
3.0	33.3
6.0	31.1
9.0	28.2
11.0	27.0
15.0	24.8
19.0	23.3
20.0	22.5
23.0	21.4
28.0	19.7
34.0	18.0
42.0	16.3
46.0	15.5
62.0	13.3
100.0	11.0
120.0	10.5
150.0	10.1
170.0	10.0
300.0	10.0
400.0	10.0
500.0	10.0
513.0	10.2
515.0	10.5
519.8	12.1
520.0	13.8
520.3	14.8
520.5	16.3
521.0	17.6
530.0	18.6
534.0	21.0
540.0	23.7
546.0	25.5
552.0	26.7
556.0	27.3
559.8	28.2
560.5	29.9

SHORT CIRCUIT TEST
of
RANGE SAFETY COMMAND BATTERY
RELIEF VALVE

TABLE III

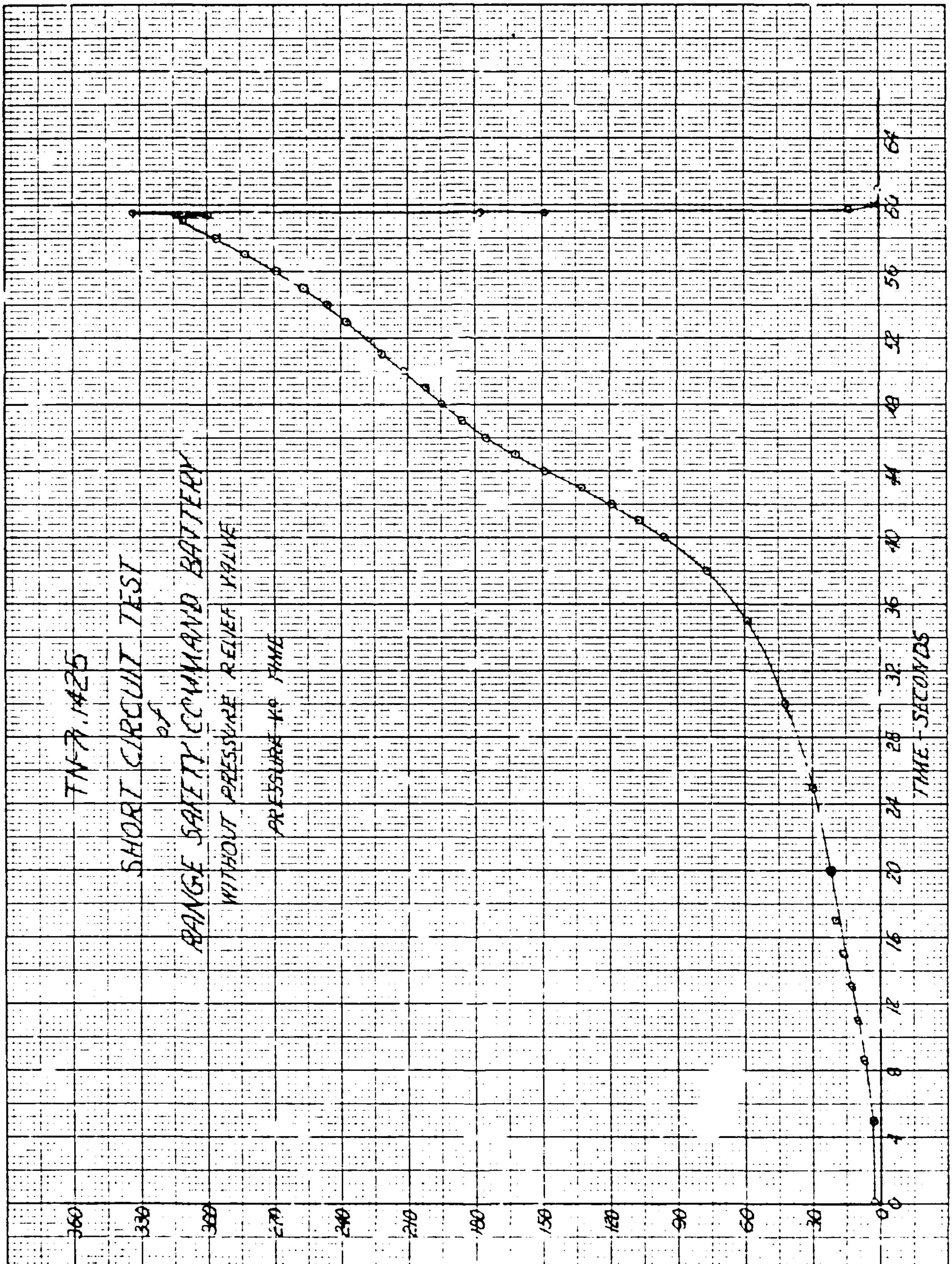
BATTERY CANISTER WITHOUT
SAFETY PRESSURE RELIEF VALVE

TIME SEC.	PRESS. PSI.	TIME SEC.	PRESS. PSI.	TIME SEC.	PRESS. PSI.
0	3	47.0	186	59.50	149
5.0	3	48.0	194	59.51	111
8.5	7	49.0	202	59.52	83
11.0	10	50.0	212	59.53	66
13.0	13	51.0	220	59.54	55
15.0	16	52.0	228	59.55	45
17.0	20	53.0	238	59.56	42
20.0	22	54.0	246	59.57	36
25.0	30	55.0	257	59.58	33
30.0	42	56.0	269	59.59	29
35.0	59	57.0	283	59.60	28
38.0	77	58.0	296	59.65	17
40 0	96	59.0	311	59.70	12
41.0	107	59.20	313	59.80	4
42.0	119	59.21	305	59.90	3
43.0	133	59.22	306	60.00	1
44.0	148	59.30	306	60.50	1
45.0	162	59.40	308	61.50	0
46.0	175	59.49	333		



TN 7A1425
ALTITUDE TEST
of
RANGE SAFETY COMMAND BATTERY
RELIEF VALVE
DRY RELIEF VALVE
ELECTROLYTE SOAKED RELIEF VALVE
ABSOLUTE PRESSURE - INCHES of MERCURY
TIME - SECONDS
39
36
33
30
27
24
21
18
15
12
9
6
3
0
100
200
300
400
500
600
700
800
900
D.F.K.
3-10-58

Fig. 1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SHORT CIRCUIT TEST
of
RANGE SAFETY COMMAND BATTERY
WITHOUT PRESSURE RELIEF VALVE
PRESSURE vs TIME
TIME-SECONDS
0 4 8 12 16 20 24 28 32 36 40 44 48 52 56 60 64
PRESSURE - PSIG
0 30 60 90 120 150 180 210 240 270 300 330 360
D.F.K.
3-10-58

Fig 2

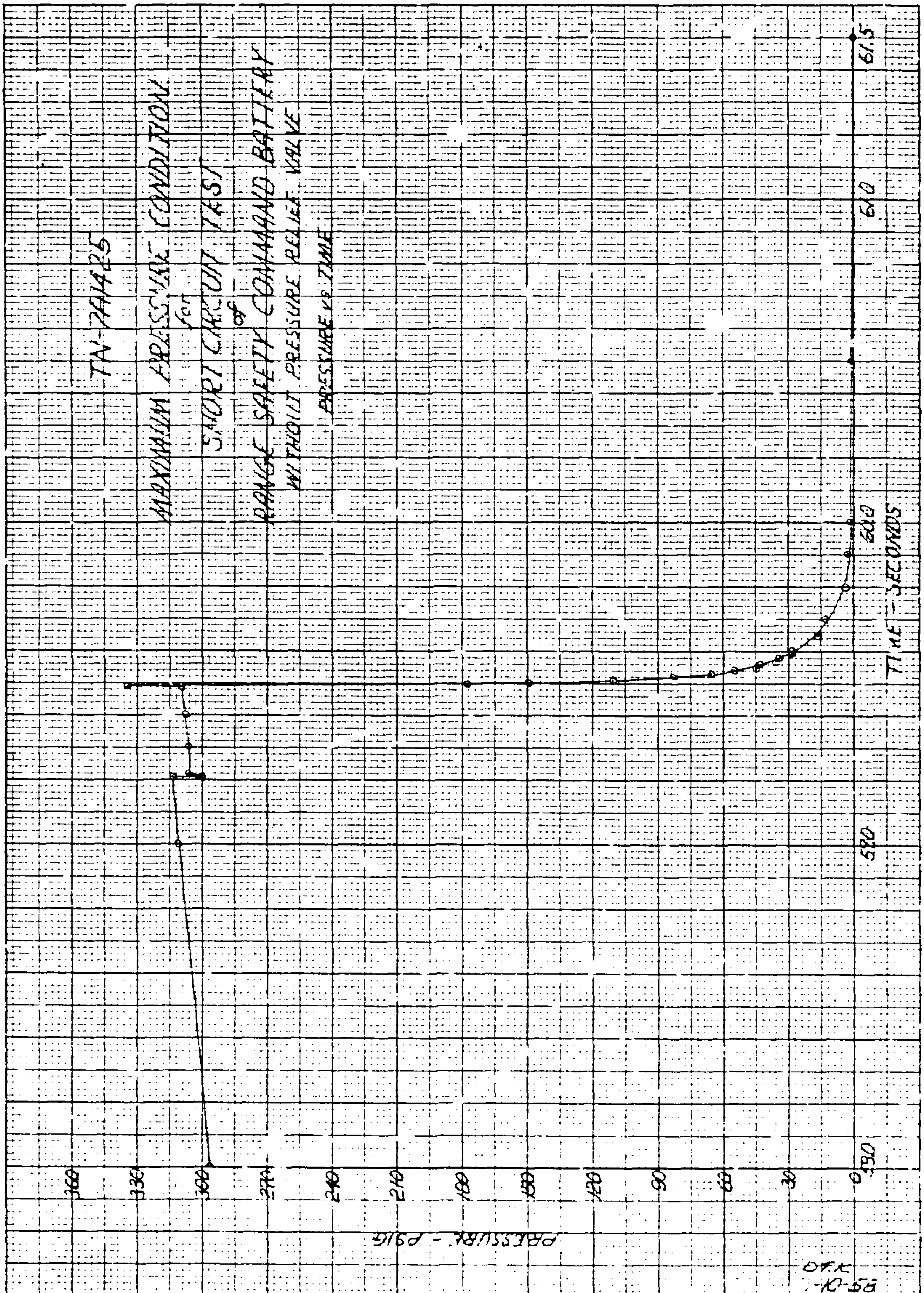
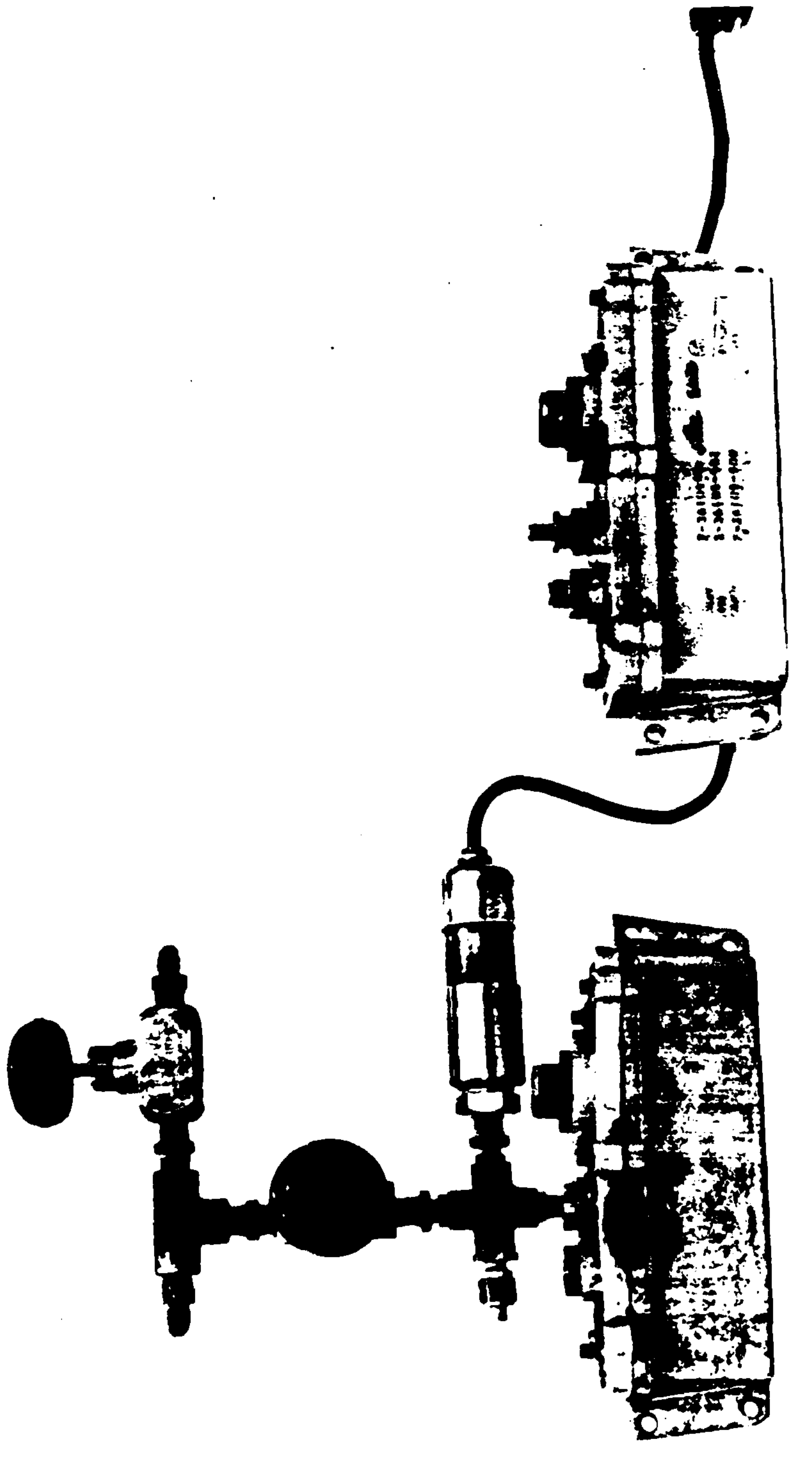

TN-7A1425
MAXIMUM PRESSURE CONDITION
for
SHORT CIRCUIT TEST
of
RANGE SAFETY COMMAND BATTERY
WITHOUT PRESSURE RELIEF VALVE
PRESSURE vs TIME
TIME - SECONDS
PRESSURE - PSIG
360
330
300
270
240
210
180
150
120
90
60
30
0
580
590
600
610
615
DFK
10-58

Fig. 3

PHOTO INDEX



SPECIMEN - B
WITH RELIEF VALVE

SPECIMEN - A
WITHOUT RELIEF VALVE

SHORT CIRCUIT TEST
RANGE SAFETY COMMAND
BATTERIES

SEALED POSITION

Fig. 4

SPECIMEN - A
WITHOUT RELIEF VALVE

SPECIMEN - B
WITH RELIEF VALVE

SHORT CIRCUIT TEST
RANGE SAFETY COMMAND
BATTERIES

OPEN POSITION

Fig. 5